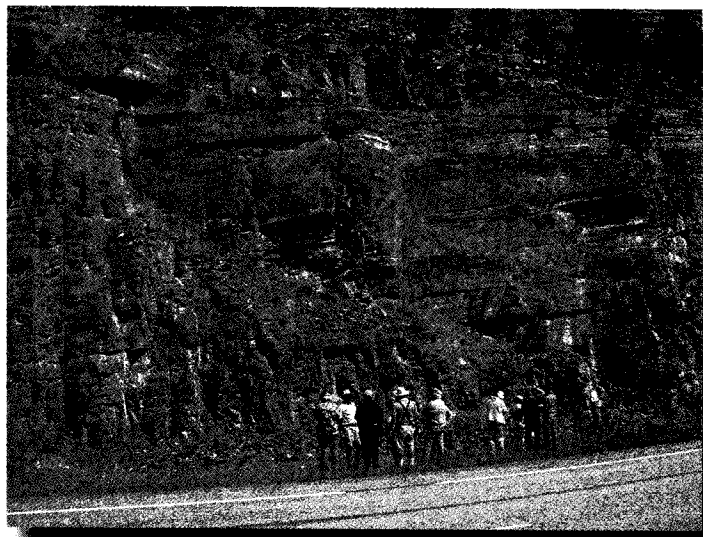


Introduction to the MBMG

Geology permeates our daily lives to an extent that few of us realize. The very shape of the landscape, the earth resources upon which our society depends, and the health and safety of our communities that may be at risk from geologic hazards are all part of the geologic fabric that surrounds us. Policy decision makers at State and local levels often face conflicting opinions and options regarding competing interests for land, water, mineral, and energy resources. Identification and mitigation of existing and potential geologic hazards, including those that we create and others that are entirely natural, may be surprisingly controversial. Geologic information is critical in resolving these and many other issues.



Since 1919, the Montana Bureau of Mines and Geology (MBMG) has been directed by the legislature to address these issues; we are also uniquely qualified to provide integrated answers to these issues. The MBMG is a non-regulatory, applied-research and public-service agency, and the State's geological survey. Our staff scientists have extensive knowledge of ground-water evaluation and protection, superfund sites, resource development and extraction, geologic mapping, and overall expertise in the geology of Montana.

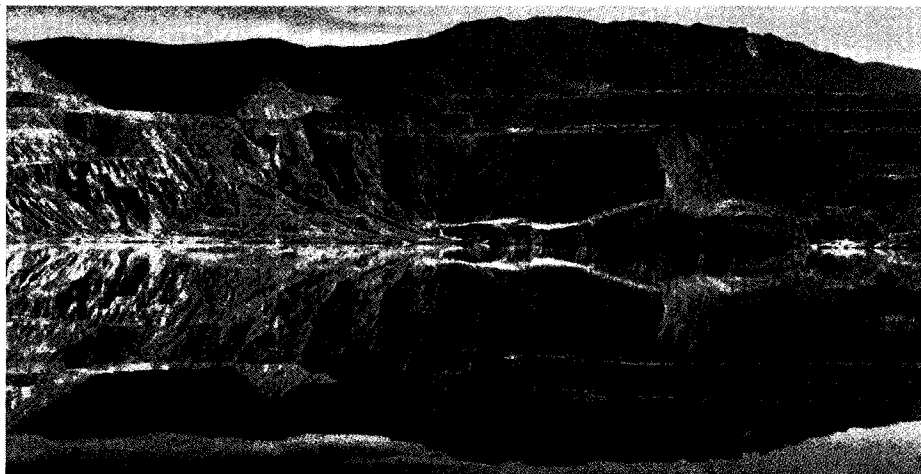
What's New in the 2007 Biennium

- *New coal/coalbed-methane geologist
- *New statewide geologic map
- *New with GWIC: DrillerWeb
- *New screening analysis for pharmaceuticals in water
- *New ICP instrument provides parts per trillion detection limits and isotope analyses
- *New Biennial Report (available now)
- *Plans for our new Natural Resources building



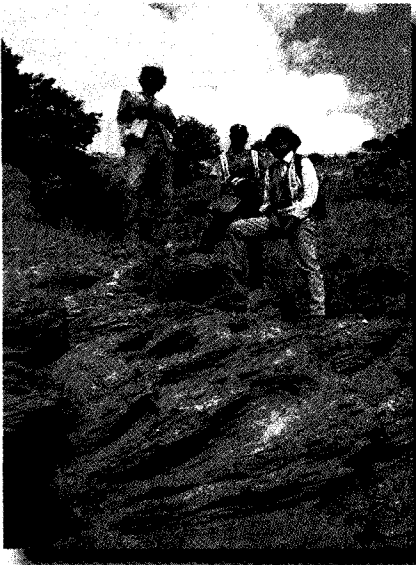
The demand for oil and gas, coal and coalbed methane, cement and lime (limestone), metals, and industrial minerals (talc and garnet) is unprecedented and has fueled Montana's economic growth. As the local economy grows, so does our local demand on those same resources and more—including water. It is easy to see why investigations related to geology, mining, and ground water in Montana are in high demand. In response to that demand, the Montana Bureau of Mines and Geology is actively participating in nearly 100 projects related to minerals and water in virtually every county in the State.

The Montana Bureau of Mines and Geology continues to utilize its grants and contracts program to better serve the needs of Montana citizens and to broaden its overall effectiveness. During the past 2 years, MBMG professionals in Butte and Billings have been involved in 90 outside-funded projects cooperating with 97 different local, State, Federal, and private organizations. These projects, evaluating virtually all aspects of Montana's vast water and mineral resources, are distributed throughout Montana. Many of our projects include students from the Montana University System, providing educational opportunities in earth sciences, engineering, and computer science.



The Berkeley Pit. MBMG staff maintain the the Butte Mine Flooding monitoring network, along with Montana Resources and ARCO.

Geology



As Montana's geological survey, the MBMG has been engaged for many years in the acquisition of geologic data and the representation of these data on geologic maps. Accurate and appropriately scaled maps are fundamental to addressing virtually every kind of question concerning the earth's surface and subsurface: quantity and quality of ground water, potential for earthquakes, potential for unstable slopes, potential for underground storage of various gases, reserves of commodities like coal

and other fossil fuels, extent of mineralization, occurrence of swelling soils, post-fire reclamation, and location and platting of subdivisions, roads, and waste-disposal and power facilities. There is no activity humans engage in on the land surface that cannot benefit from geologic information.

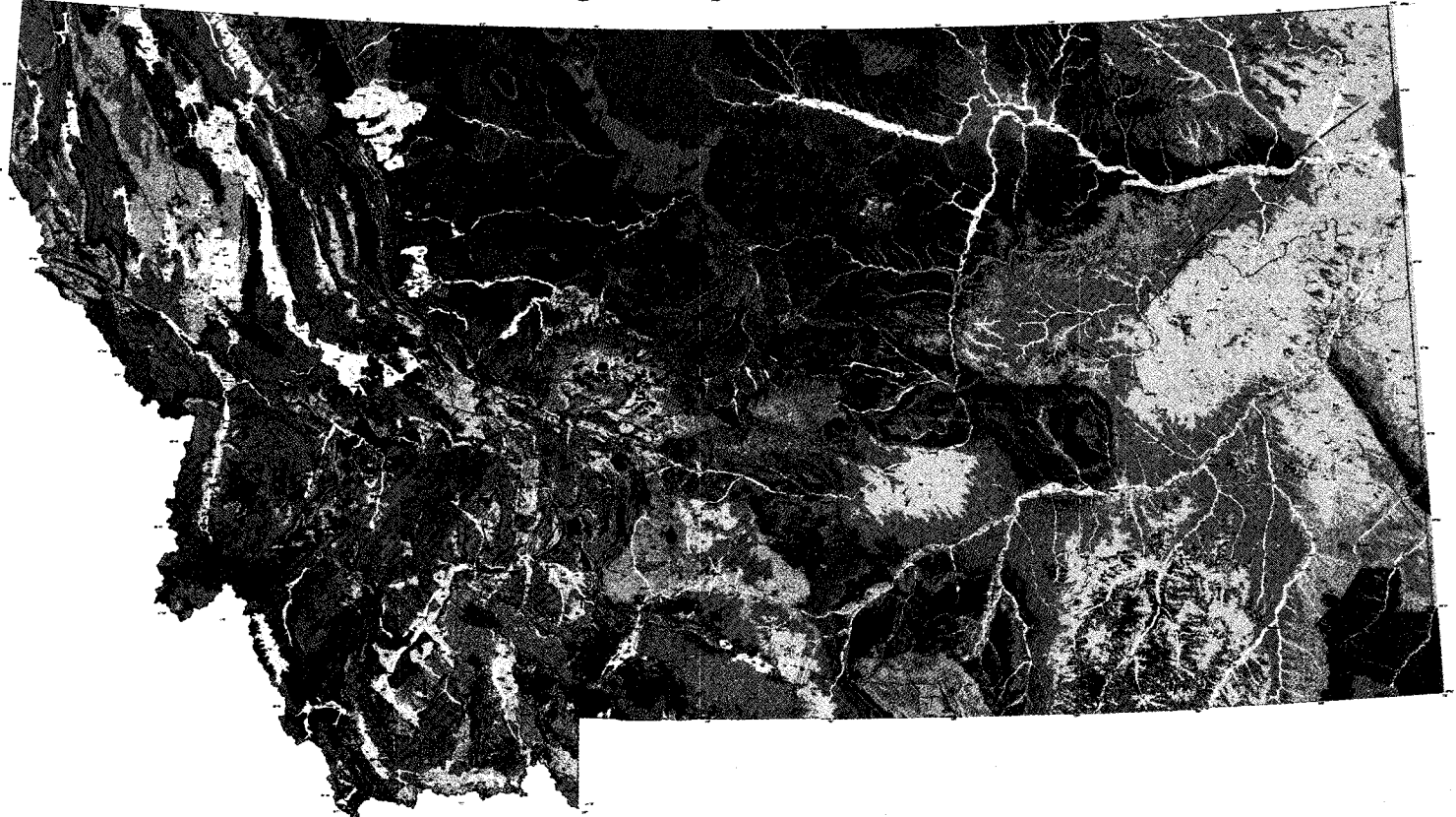
The MBMG's mapping program is supported by State general funds and matching dollars from STATEMAP, a competitive grant component of the National Cooperative Geologic Mapping Program (NCGMP). To date, the MBMG's geologic mapping program has provided digital coverage for 81% of

Montana's land surface, represented on 76 integrated geologic maps of several scales and delineating approximately 700 different rock units. These data can be integrated with other types of information, using GIS, to address all land-surface issues. In addition to conducting our own geologic mapping, each year MBMG staff work with several graduate students doing field theses in Montana, funded by the EDMAP component of the NCGMP. The MBMG has responsibility for recommending projects to be funded and for production of the final maps.

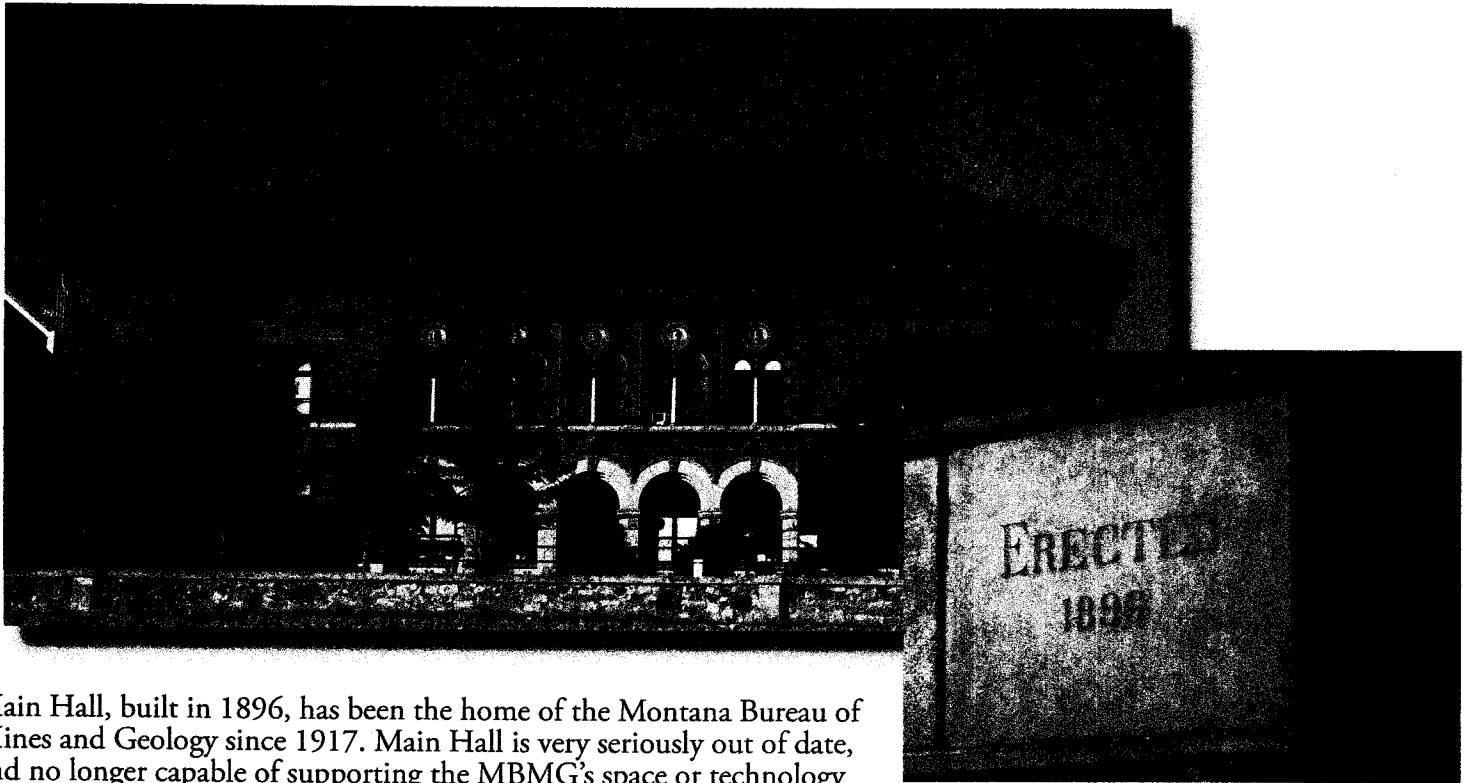
A new digital geologic map of the State will be released this spring (a small representation of the map is below). This map will incorporate considerable new geologic information and interpretations that were not available in 1955 when the last map was published, and represents an effort that began more than 10 years ago. The new geologic map will be our springboard for providing the latest geologic mapping information in the coming years.

The MBMG puts great effort into public service, particularly into making our data publicly available. Staff members spend countless hours providing information to individuals or groups, mostly within the State. The traditional methods of information transfer through either our own or external printed publications have been augmented by the astounding growth in delivery of data via the Internet. In the past calendar year, approximately 65,000 copies of publications, mostly geologic maps, were downloaded through the main MBMG website. All of these data were provided at no cost to the user.

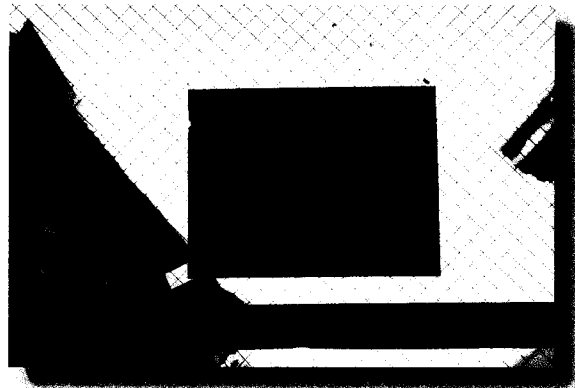
Geologic Map of Montana



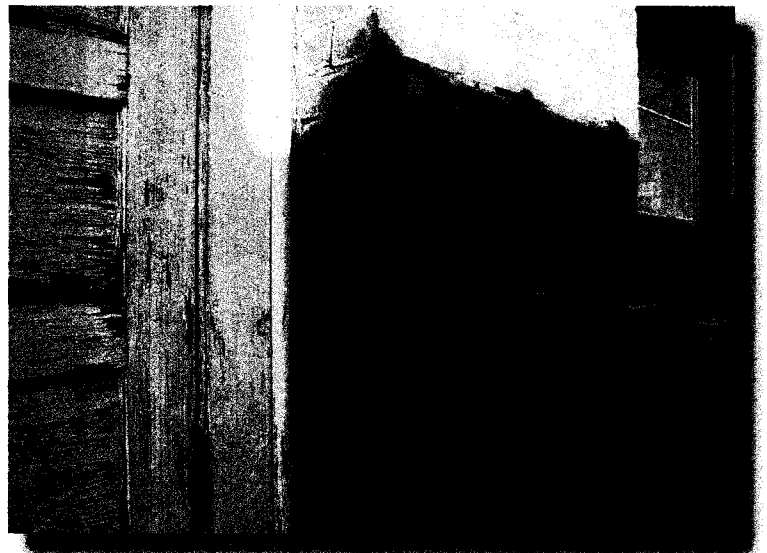
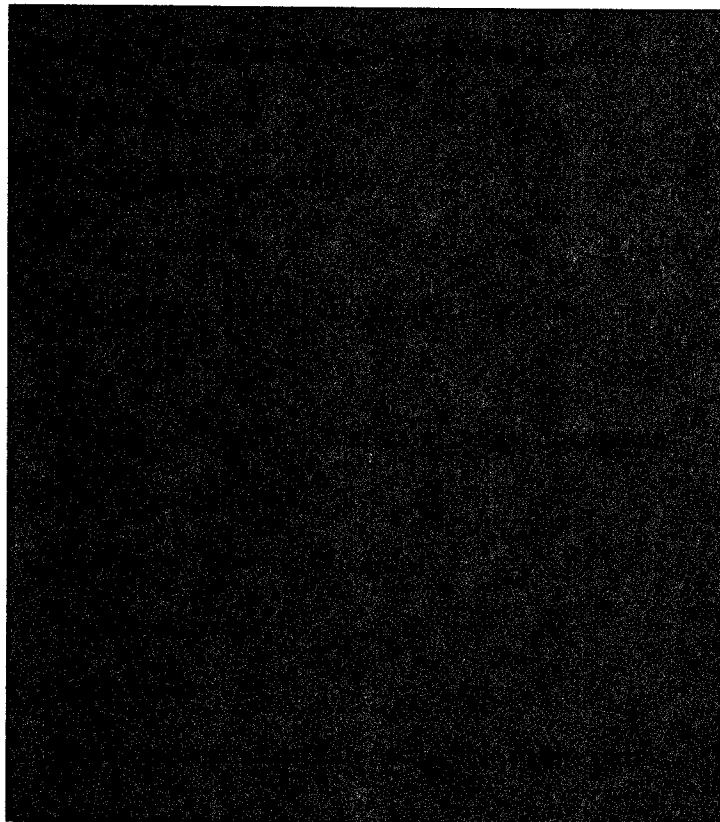
The Case for a New Building



Main Hall, built in 1896, has been the home of the Montana Bureau of Mines and Geology since 1917. Main Hall is very seriously out of date, and no longer capable of supporting the MBMG's space or technology needs; public access is difficult and handicapped access is non-existent.

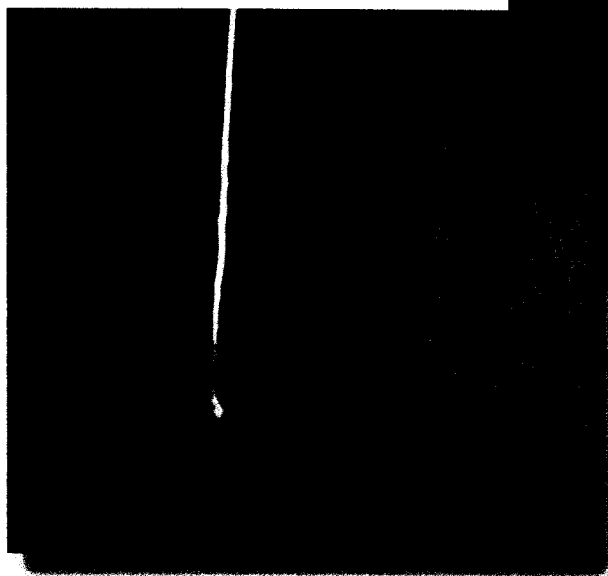


Sign posted after window fell out, 3rd floor.

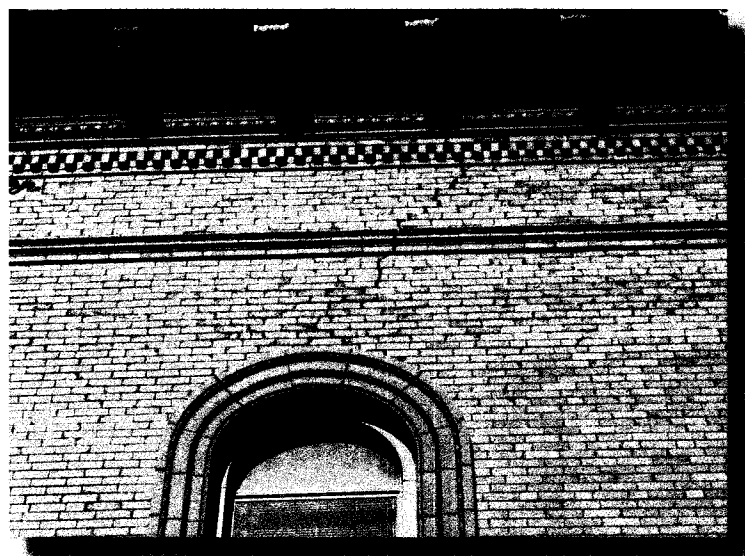


Crumbling brick in exterior wall, 3rd floor.

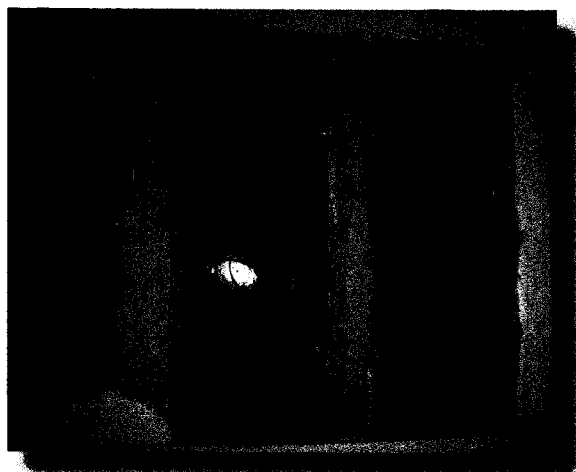
Right: Ceiling in basement map room.



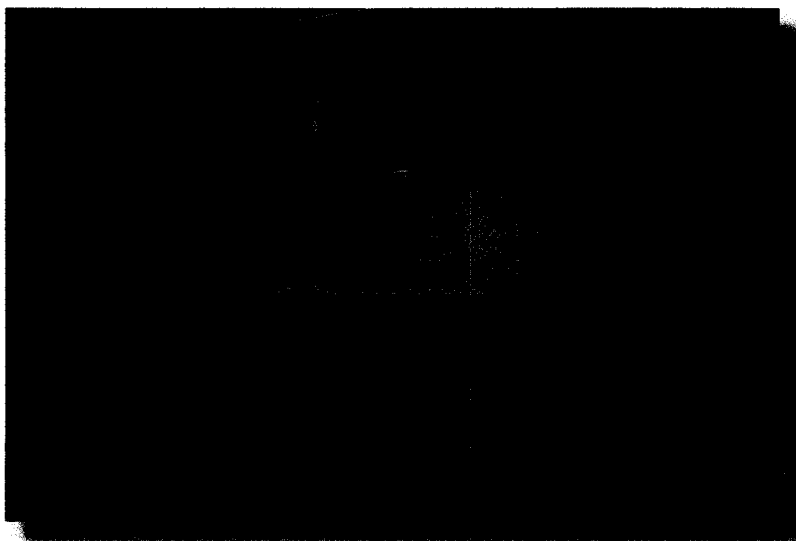
Cracks in basement support wall.



Crack in exterior wall, 3rd floor.



Electrical wiring, basement.



Analytical lab, basement.

Ground-Water Assessment



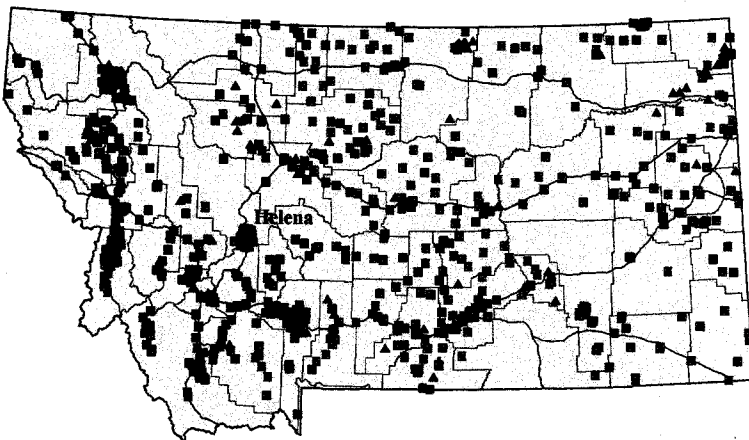
The Legislature established the Ground-Water Assessment Program (85-2-901 et seq.) in 1991 after considering the recommendations of a Ground-Water Task Force organized by the Environmental Quality Council. Statute specifically requires systematic monitoring and characterization of aquifers to improve understanding of Montana's ground-water resources. As part of a mandate to make ground-water information widely available, the Assessment Program includes the Ground-Water Information Center (GWIC) database at the Montana Bureau of Mines and Geology. The

Legislature also created an

interagency Steering Committee that selects study areas, addresses the need for better coordination among State, Federal, and local government units, and oversees Assessment Program progress.

Ground-Water Monitoring

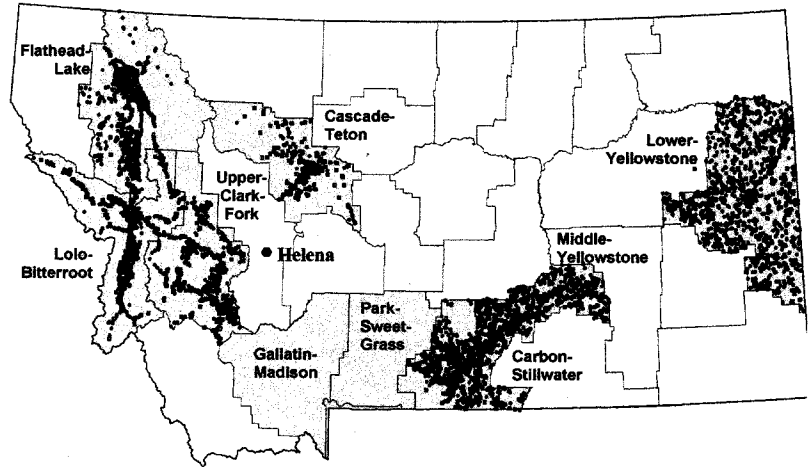
The Ground-Water Monitoring Program measures water levels in 899 strategically located wells each quarter (see map below). Long-term records of water levels in wells are like long-term records of stream flow, and provide information about how ground water responds to seasonal and climatic changes. Water levels in wells also can respond to other factors such as increased withdrawals due to population growth, or from land use change. Without long-term records, these effects are difficult or impossible to distinguish.



Information from the Ground-Water Monitoring Program helps people understand the impact of drought on water levels in wells. Since 2000, about 75 percent of climate-sensitive wells are below their seasonal averages.

Ground-Water Characterization Program

The Characterization Program includes a detailed study of the aquifer system within a specific area. Study areas are prioritized by the Ground-Water Assessment Steering Committee. The locations for more than 6,533 visited wells (dots) and 1,405 samples (yellow squares) collected by Characterization Program staff are shown on the map below.



The Gallatin-Madison and Park-Sweet Grass characterization areas have been selected for future work. Field work is ongoing in the Cascade-Teton characterization area and will begin in the Gallatin-Madison area in spring 2008. The hydrogeology of active/completed characterization areas in 17 counties have been compiled into a series of maps and atlases that cover each area. Since July 2005, 991 maps have been delivered by the GWIC website.

Ground-Water Information Center (GWIC)

GWIC customers seek ground-water data generated by MBMG ground-water-projects, logs from water-well drilling, and results from water-quality sampling.

On July 1, 2004 drillers began filing well logs directly with the MBMG. The MBMG was also allowed to

accept electronic copies of the log. In March 2004 MBMG launched "DrillerWeb," an Internet tool that licensed water-well drillers can use to file water-well logs. DrillerWeb allows a driller to enter and edit data, print well log reports for their customers, manage their well log data in their own "private" account, and at the same time complete their obligation to the state. By November 2006 more than 4,100 logs had been filed through DrillerWeb.

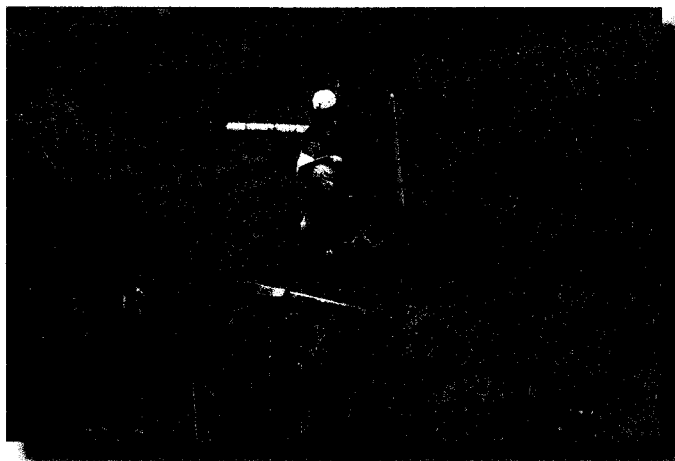
GWIC by the Numbers

- *More than 10,700 users
- *Currently about 4,900 sessions and 38,000 queries each month
- *Information on 204,200 wells
- *Results from 32,000 water-quality analyses on 14,350 sites
- *1.3 million water-level measurements

According to the Montana Natural Resource Information System, ground water provides 94 percent of Montana's rural domestic water supply and 39 percent of the public water supply. The MBMG has over 80 active projects related to surface water and ground water in Montana and focuses on issues critical to water use in agricultural, domestic, fisheries, municipal, and industrial applications.

Water Supply: Quantity and Quality

The demand for abundant, clean ground water grows with the approval of each new subdivision. The MBMG is participating in several projects related to the increasing demand for ground water in new developments and the cumulative impact of septic systems in existing developments. Many areas of Montana have seen a change from agricultural land use to subdivisions and shopping centers. This often means that the irrigated land that was providing recharge to ground water is converted to residential areas with runoff control that actually reduces recharge and adds high demands on ground-water discharge. Such change often has dramatic effects on ground-water flow and quality that are just recently being realized. Of course, the demand for ground water also increases for every year of the drought. Surface-water shortages for agricultural purposes or for drought-stricken communities are being replaced by wells, increasing reliance on the ground-water supply.



Monitoring Programs

Ground-water flow and quality respond to many influences, both man-made and natural. Several long-term monitoring programs are underway—some for over 30 years now—that provide data for decision makers to address natural and human influences on ground water and geothermal resources, evaluate reclamation in hard-rock and coal mines, and mitigate the effects of the sustained drought. Some of these programs include monitoring

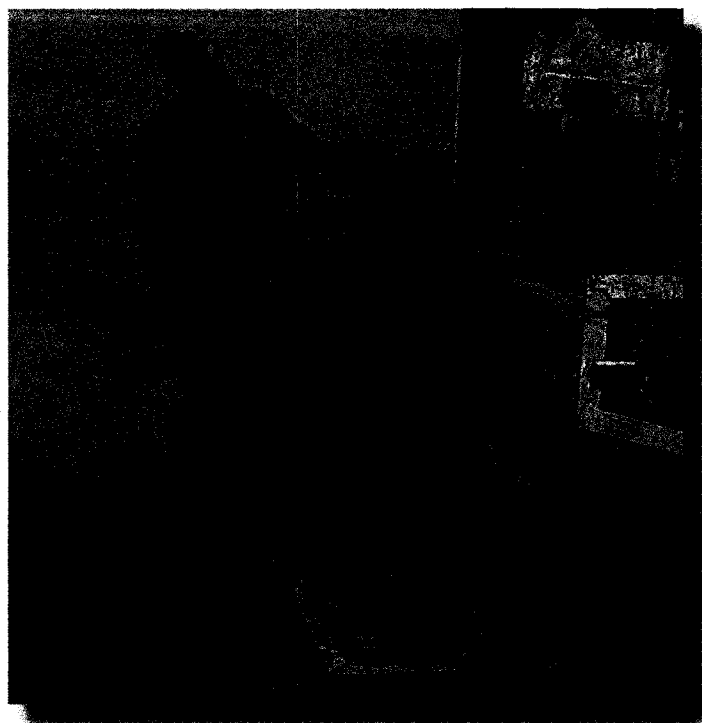
of the geothermal area near Yellowstone National Park, the Berkeley Pit and underground workings in Butte, coal strip mines and coalbed-methane fields in southeastern Montana, Big Muddy Creek in the northeast, and post-reclamation monitoring for several hard-rock mines in western Montana.

Special Studies in Ground Water

The MBMG is conducting several investigations related to specific localities or specific issues statewide. Nitrate in ground water has become a challenge for new subdivisions and must be addressed separately for each site. Similarly, pharmaceuticals and other chemicals are finding their way from septic tanks to ground-water supplies. New analytical tools such as isotopes and new analytical instruments for organic chemicals are being employed to develop a better understanding of how ground water can be protected.

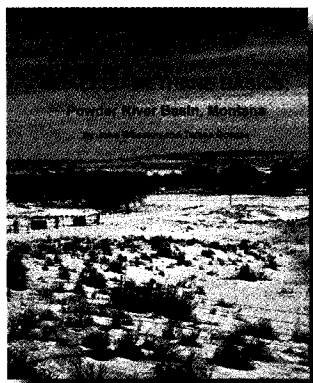
Some Current MBMG Water-Resources Projects

- * Yellowstone Controlled Ground-Water Area
- * Big Hole Watershed Management Project
- * Watershed and Ecosystems: A Backyard Classroom
- * Salinity Risk Model for the Bullhead Valley
- * Helena Valley Ground Water: Pharmaceuticals, Personal Care Products, Endocrine Disruptors, and Microbial Indicators of Fecal Contamination
- * Rehabilitating Flowing Wells in the Big Spring Watershed
- * Irrigation Potential of Ground Water Underlying the Lower Yellowstone Valley
- * Impacts of Oilfield Wastes on Natural Resources
- * Improving Soil Productivity and Water Quality in South-Central Montana
- * Evaluation of Coalbed-Methane Infiltration Ponds
- * Coal Lands Hydrogeology



Energy Resources

Coal is an important energy resource for the U.S., with more than half of current electricity produced by coal-fired power plants. Department of Energy data indicate that Montana's mineable reserve base is the largest of any state. Understanding the quantity, distribution, and quality of these coal reserves is essential for efficient development of this resource. The USGS established the National Coal Resources Data System (NCRDS) as part of their National Coal Resource Assessment Program. The MBMG has collected information on many aspects of coal in Montana for over 20 years; these data are prepared and entered into the NCRDS database. Coalbed methane (CBM) is also a critical resource for Montana.



This free publication, published in 2004, provides basic CBM information for all Montanans.

Underground coal gasification (UCG) is a technology that has been around since World War II; higher petroleum prices and advancement in recovery techniques have renewed interest in UCG here in Montana. The MBMG has responded to several requests from private and government interests regarding potential development. A recent analysis by the MBMG applied such criteria as coal extent, depth, permeability, and quality to identify potential areas of UCG development.

Oil exploration and discovery are also extremely important for Montana's economy. More than 2 billion barrels of oil have been produced from the Big Horn Basin and more than 525 million barrels of oil from the Powder River Basin. The MBMG is actively involved with private industry and with the Crow Tribe in southeastern Montana to develop a new exploration model for the Permo-Pennsylvanian petroleum system; generate maps for industry showing an exploration fairway for oil accumulations in this system; reduce exploration costs by allowing focused exploration in the fairway; and ultimately add petroleum reserves from new discoveries.

Coalbed-Methane Development in Montana

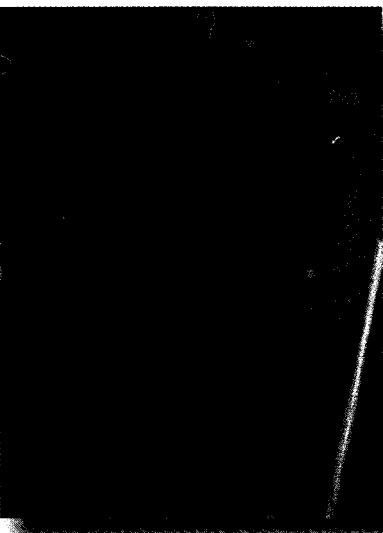
*Began in 1999 with 127 wells producing 8 million cubic feet of methane gas per day

*As of December 2005 there were 516 wells producing 10.5 million Mcf (Mcf = 1,000 cubic feet) per year

*The gas is a high BTU, clean-burning fuel

*Within the Montana portion of the Powder River Basin, 7,500 to 26,000 CBM wells are expected to be drilled in the next 20 years

Mineral Resources



The MBMG has a continuing program of research into mineral commodities that are either being mined or have the potential to be mined in Montana. In recent years the results of investigations on barite, talc, chlorite, vermiculite, and zeolites have been released. Current research is now being focused on metallic districts and gold placers; of particular interest in recent years are sapphire deposits. Known deposits have produced more than 50 tons of sapphires, but the bedrock sources have generally not yet been determined. The MBMG

also houses an inventory of maps, mineral property files, and production records on properties; these are primarily metallic minerals but include industrial commodities.

The MBMG's staff mining engineer regularly visits mining and exploration operations across Montana as part of our Small Mine Operators Assistance Program. Technical services typically include operational instruction, feasibility assistance, geologic mapping, surveying, sampling instruction, mine design, reclamation planning, and permitting guidance. Our engineer and geologists answer hundreds of inquiries related to minerals and mining each year.

Mineral Museum

The Mineral Museum has over 1,300 mineral specimens on display and an additional 15,000 specimens in storage. A computerized database facilitates information acquisition on the accessioned collection. Group tours are an important activity of the museum, and during the past biennium about 1,500 individuals in over 80 groups were guided through our displays—over and above our 12,000 individual visitors. In addition to invited speakers and field tours related to mining and minerals, the staff of the museum and the MBMG hold several sessions throughout the year where grade school students are invited to participate in exercises to demonstrate how to find mineral specimens and learn about the many uses of minerals.



Earthquake Studies

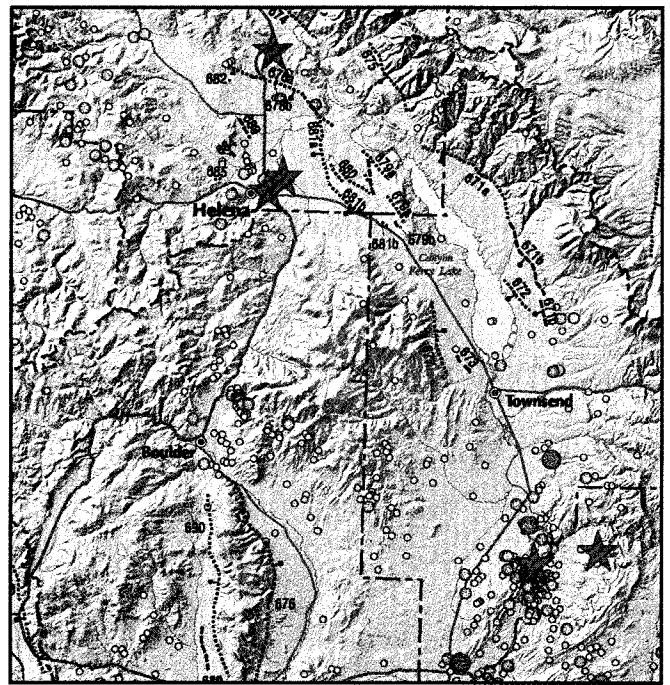
--"We learn geology the morning after the earthquake."
Ralph Waldo Emerson, U.S. Poet, essayist and transcendentalist (1803-1882).

Western Montana has a history of large, damaging earthquakes and remains seismically active.

Many of these earthquakes (including the magnitude 6.8 quake north of Three Forks in 1925 and the 1935 magnitude 6.3 and 6.0 quakes that badly damaged Helena) occur at depth along faults that do not extend to the earth's surface. The seismic hazards associated with earthquakes on these "blind" faults cannot be evaluated with traditional geologic studies of faults and are best studied with data from a permanent network of seismograph stations. As the population and infrastructure of earthquake-prone western Montana continues to grow, the exposure to seismic hazards increases.

A network consisting of 38 seismic monitoring stations operates throughout western Montana, the most seismically active region of the State. Four additional stations operate in less seismically active eastern Montana. Other regional seismic monitoring centers provide additional seismic data from stations in the surrounding region (Yellowstone Park, central Idaho, and southern Canada).

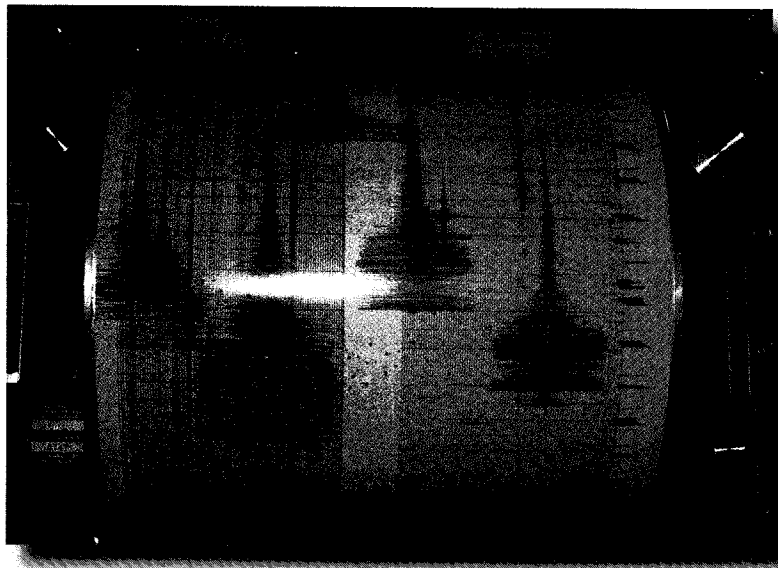
The MBMG records a total of 171 channels of seismic data from 82 local and regional stations; improvements in the system enable near-real-time reporting of significant events to the National Earthquake Center, where they are used by



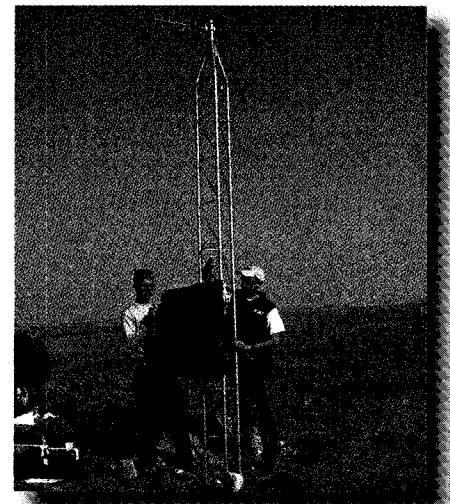
A portion of MBMG Special Publication 114 showing known potentially active faults in the Helena region along with selected earthquake epicenters.

appropriate State and Federal agencies (Montana Disaster and Emergency Services, Montana Dam Safety Program, CSKT Dam Safety Program, and USGS), the public, and the media. Using the data from this extensive seismograph network, the times, locations, and magnitudes of earthquakes are determined and catalogued.

A listing of recent earthquakes, along with other information about seismic hazards in Montana, is available on the MBMG Earthquake Studies Office website (<http://mbmgquake.mtech.edu/>).



Seismograph record of the July 2005 5.6-magnitude earthquake centered in Dillon.



Contact the Montana Bureau of Mines and Geology:

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